

## SEQUENCE LISTING

&lt;110&gt; DSM IP ASSETS B.V.

&lt;120&gt; BIOSYNTHETIC PATHWAY GENES

&lt;130&gt; N.84450A SMW

&lt;140&gt;

&lt;141&gt;

&lt;150&gt; EP 02255203.8

&lt;151&gt; 2002-07-25

&lt;160&gt; 17

&lt;170&gt; PatentIn version 3.1

&lt;210&gt; 1

&lt;211&gt; 2586

&lt;212&gt; DNA

&lt;213&gt; Propionibacterium freudenreichii

&lt;220&gt;

&lt;221&gt; CDS

&lt;222&gt; (1) .. (2586)

&lt;223&gt;

&lt;400&gt; 1

atg	gtg	acg	gcg	acg	gct	ctt	ccg	cgg	gtg	ctc	atc	gcg	gcc	ccc	gcg	48
Met	Val	Thr	Ala	Thr	Ala	Leu	Pro	Arg	Val	Leu	Ile	Ala	Ala	Pro	Ala	
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tcc	agc	cag	gga	aag	acc	acc	gtg	gcc	atc	ggc	ctg	atg	gcg	gcc	ctg	96
Ser	Ser	Gln	Gly	Lys	Thr	Thr	Val	Ala	Ile	Gly	Leu	Met	Ala	Ala	Leu	
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cgg	gcc	tcg	ggg	cgc	agc	gtg	gcc	gga	ttc	aag	gtg	ggc	ccc	gac	tac	144
Arg	Ala	Ser	Gly	Arg	Ser	Val	Ala	Gly	Phe	Lys	Val	Gly	Pro	Asp	Tyr	
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Ile	Asp	Pro	Gly	Tyr	His	Ala	Leu	Ala	Cys	Gly	Arg	Pro	Gly	Arg	Asn	
	50					55				60						

ctg	gat	ccc	tat	ttg	tgc	ggg	ccc	gag	cgc	att	gcg	ccg	ttg	ttc	gcc	240
Leu	Asp	Pro	Tyr	Leu	Cys	Gly	Pro	Glu	Arg	Ile	Ala	Pro	Leu	Phe	Ala	
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cat	ggc	gcg	ctg	cat	ccc	gaa	ccc	gcg	gac	atc	tcg	gtc	gtc	gaa	ggc	288
His	Gly	Ala	Leu	His	Pro	Glu	Pro	Ala	Asp	Ile	Ser	Val	Val	Glu	Gly	
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gtg	atg	ggc	atg	ttc	gac	ggc	aag	ctc	ggc	gcg	tgg	ccc	gac	ggc	acc	336
Val	Met	Gly	Met	Phe	Asp	Gly	Lys	Leu	Gly	Ala	Trp	Pro	Asp	Gly	Thr	
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gat	gac	ccc	gcc	ggt	ttt	ggc	tca	tcg	gcc	cat	atc	gcc	agg	ctg	ctc	384
Asp	Asp	Pro	Ala	Gly	Phe	Gly	Ser	Ser	Ala	His	Ile	Ala	Arg	Leu	Leu	

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gat gcc ccc gtg ctg ctc gtg gtc gac ggc tca cac agt gcc cgt acc Asp Ala Pro Val Leu Leu Val Val Asp Gly Ser His Ser Ala Arg Thr 130 135 140			432
gcc gca gcc ctg tgc cat ggc ctg gcc agc tac gat ccc cgc atc cat Ala Ala Ala Leu Cys His Gly Leu Ala Ser Tyr Asp Pro Arg Ile His 145 150 155 160			480
gtg gcc ggc gtc atc ctc aat cgg gtg atg ggt gcc cgc gtg gtc gac Val Ala Gly Val Ile Leu Asn Arg Val Met Gly Ala Arg Val Val Asp 165 170 175			528
gag atc acc cgg ggc tgc gca cgt gtc ggc ctg ccg gtg ctg ggg gct Glu Ile Thr Arg Gly Cys Ala Arg Val Gly Leu Pro Val Leu Gly Ala 180 185 190			576
ctg ccg aaa agc acg cgg gtg gcc gtg ggc tca cgc cac ctg gga ctg Leu Pro Lys Ser Thr Arg Val Ala Val Gly Ser Arg His Leu Gly Leu 195 200 205			624
gtc acg gcc gac gag cag ggt gac gcg atc ggc atc gtg cag cag gcc Val Thr Ala Asp Glu Gln Gly Asp Ala Ile Gly Ile Val Gln Gln Ala 210 215 220			672
ggt gag ctc gtc gcc gca cac ctc gac ctc gac gcc atc gcc acg atc Gly Glu Leu Val Ala Ala His Leu Asp Leu Asp Ala Ile Ala Thr Ile 225 230 235 240			720
gcc ggt ggg gcc cct gac ctg gcc gtc gat ccc tgg gat ccc gcc gca Ala Gly Gly Ala Pro Asp Leu Ala Val Asp Pro Trp Asp Pro Ala Ala 245 250 255			768
gag gtc gaa ccg gta ccg ggg cgt ccg gtc atc gcc atg gcc tcg ggt Glu Val Glu Pro Val Pro Gly Arg Pro Val Ile Ala Met Ala Ser Gly 260 265 270			816
ccc gca ttc acc ttc cgg tac acc gaa acc gca gaa ctg ctg gag gcg Pro Ala Phe Thr Phe Arg Tyr Thr Glu Thr Ala Glu Leu Leu Glu Ala 275 280 285			864
gcc ggc tgc cgg gtg acg gcc ttc gat ccg ctc acc gcc cgg ggc ctt Ala Gly Cys Arg Val Thr Ala Phe Asp Pro Leu Thr Ala Arg Gly Leu 290 295 300			912
ccg gcc gat gtg tcc ggc ctg tac ctg ggg ggt ggt ttc ccc gag gag Pro Ala Asp Val Ser Gly Leu Tyr Leu Gly Gly Gly Phe Pro Glu Glu 305 310 315 320			960
cac gcc gag gcg ctc gcc ggc aac acc tcc ctg ggc gct gaa atc gcc His Ala Glu Ala Leu Ala Gly Asn Thr Ser Leu Gly Ala Glu Ile Ala 325 330 335			1008
tca cgc gtg tcc gag ggc ctg ccg acg gtg gcc gag tgt gcg ggg ctg Ser Arg Val Ser Glu Gly Leu Pro Thr Val Ala Glu Cys Ala Gly Leu 340 345 350			1056
ctc tac ctg tgc cgc agc ctg gat gga ctg gcg atg gcc ggg gtg gtc			1104

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gac	gcc	gac	tcg	tcc	atg	acg	ccg	cgc	ctg	acc	atc	ggc	tac	cac	cac	1152	
Asp	Ala	Asp	Ser	Ser	Met	Thr	Pro	Arg	Leu	Thr	Ile	Gly	Tyr	His	His		
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Ala	Arg	Ala	Ala	Asn	Asp	Ser	Phe	Leu	Met	Arg	Ala	Gly	Glu	Arg	Tyr		
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Arg	Ala	His	Glu	Phe	His	Arg	Thr	Thr	Leu	Asp	Thr	Pro	Pro	Tyr	Asp		
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cgc	gac	ccc	gga	cca	caa	cgg	ctg	ggc	gac	caa	cgg	ttg	gcg	tgg	gac	1296	
Arg	Asp	Pro	Gly	Pro	Gln	Arg	Leu	Gly	Asp	Gln	Arg	Leu	Ala	Trp	Asp		
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gtg	gag	acc	ccg	acg	ggg	ggc	aac	cga	ccc	gag	ggg	gtg	ctg	gtc	gcc	1344	
Val	Glu	Thr	Pro	Thr	Gly	Gly	Asn	Arg	Pro	Glu	Gly	Val	Leu	Val	Ala		
		435					440					445					
ccg	acc	ccc	ggt	tcc	gcg	ccc	agc	gtc	cac	gcc	tcc	tac	cag	cac	ctg	1392	
Pro	Thr	Pro	Gly	Ser	Ala	Pro	Ser	Val	His	Ala	Ser	Tyr	Gln	His	Leu		
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cac	tgg	gca	ggg	agt	cgg	gta	ctg	gcg	caa	cgc	ttc	gcc	cgg	gcg	gcg	1440	
His	Trp	Ala	Gly	Ser	Pro	Val	Leu	Ala	Gln	Arg	Phe	Ala	Arg	Ala	Ala		
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agc	gaa	tat	ggg	cac	acc	ggc	cat	cac	tcc	ccc	cgg	cct	gcc	gcc	acg	1488	
Ser	Glu	Tyr	Gly	His	Thr	Gly	His	His	Ser	Pro	Arg	Pro	Ala	Ala	Thr		
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acg	ccg	gga	gat	gcg	ttg	tcc	gca	gcg	ccc	gac	ctc	acc	cat	cac	ggg	1536	
Thr	Pro	Gly	Asp	Ala	Leu	Ser	Ala	Ala	Pro	Asp	Leu	Thr	His	His	Gly		
			500					505					510				
gat	cgc	gat	gtg	ctg	ccc	ggc	ctg	gtc	gac	ttg	gcg	gtg	aac	gtg	cgc	1584	
Asp	Arg	Asp	Val	Leu	Pro	Gly	Leu	Val	Asp	Leu	Ala	Val	Asn	Val	Arg		
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gat	gtg	cga	cct	ccg	gcc	tgg	ctc	gtg	gag	cgc	atc	gtc	gcc	tcc	agc	1632	
Asp	Val	Arg	Pro	Pro	Ala	Trp	Leu	Val	Glu	Arg	Ile	Val	Ala	Ser	Ser		
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gac	cag	tgg	gcc	cac	tac	ccc	gat	cag	cgc	gaa	gcg	acc	cgt	gcg	gtg	1680	
Asp	Gln	Trp	Ala	His	Tyr	Pro	Asp	Gln	Arg	Glu	Ala	Thr	Arg	Ala	Val		
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gca	ctg	cgc	cat	ggc	gtc	aac	ccc	gac	cag	gta	ctg	ctc	acg	gcc	ggg	1728	
Ala	Leu	Arg	His	Gly	Val	Asn	Pro	Asp	Gln	Val	Leu	Leu	Thr	Ala	Gly		
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Ser	Ser	Glu	Ala	Phe	Ser	Leu	Ile	Ala	His	Gly	Phe	Ser	Pro	Arg	Trp		
			580					585					590				

gcg gtc gtg gtg cat ccc cag ttc acc gaa cca gag gtg gcc ctg cgc	1824
Ala Val Val Val His Pro Gln Phe Thr Glu Pro Glu Val Ala Leu Arg	
595 600 605	
aac gcc ggg cgc ccg gtc ggc cgc ctg gtg ctc cat gcc tcg gat ggc	1872
Asn Ala Gly Arg Pro Val Gly Arg Leu Val Leu His Ala Ser Asp Gly	
610 615 620	
ttc cag ttc gat cac gaa ctg ctg gac ccc agg gcc gac atg gtg gtc	1920
Phe Gln Phe Asp His Glu Leu Leu Asp Pro Arg Ala Asp Met Val Val	
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Ile Gly Asn Pro Thr Asn Pro Thr Gly Val Leu His Ser Ala Ala Ser	
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ctg cgc gcg ttg tgc cgg ccc gga cgc gtg gtg gtg gtt gac gag gca	2016
Leu Arg Ala Leu Cys Arg Pro Gly Arg Val Val Val Val Asp Glu Ala	
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Phe Met Asp Ala Val Pro Gly Glu Pro Glu Ser Leu Ile Gly Ala Arg	
675 680 685	
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Met Asp Gly Leu Leu Val Thr Arg Ser Phe Thr Lys Thr Trp Ser Val	
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Pro Gly Leu Arg Ile Gly Tyr Val Val Gly Asp Pro Ala Leu Ile Arg	
705 710 715 720	
gtc ctg gcg cac gaa cag ccc tgt tgg ccc atc tcc acc ccc gcc ctg	2208
Val Leu Ala His Glu Gln Pro Cys Trp Pro Ile Ser Thr Pro Ala Leu	
725 730 735	
gtc acc gcc cgc gaa tgc tcc acg cca cgc gcc gtg gag cag gcc acc	2256
Val Thr Ala Arg Glu Cys Ser Thr Pro Arg Ala Val Glu Gln Ala Thr	
740 745 750	
tca gat gcc cga cag gcg gcg cag gac cgc cga cac ctg gtg gcc cgc	2304
Ser Asp Ala Arg Gln Ala Ala Gln Asp Arg Arg His Leu Val Ala Arg	
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ctg gcc ggg atc ggc atc cag acc gtc ggg gag gcc agg gcc ccc ttc	2352
Leu Ala Gly Ile Gly Ile Gln Thr Val Gly Glu Ala Arg Ala Pro Phe	
770 775 780	
gtc cta gtc gac ctg cgc gcc cac ccg ccc ggt ggg ctt cgt gcg gga	2400
Val Leu Val Asp Leu Arg Ala His Pro Pro Gly Gly Leu Arg Ala Gly	
785 790 795 800	
ttg cgg acg ctc ggc ttc acc gtg cgc agc ggc gag agc ttc ccc ggc	2448
Leu Arg Thr Leu Gly Phe Thr Val Arg Ser Gly Glu Ser Phe Pro Gly	
805 810 815	
ctg ggc gcg ggc tgg ttg cgg ctc gcg gtt cgc cac ccg gac atc agc	2496
Leu Gly Ala Gly Trp Leu Arg Leu Ala Val Arg His Pro Asp Ile Ser	
820 825 830	

gac gcg ttc gtc gct gcc ctg gcc cgc acc atc gac gca ctg gac aca 2544  
 Asp Ala Phe Val Ala Ala Leu Ala Arg Thr Ile Asp Ala Leu Asp Thr  
 835 840 845

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 850 855 860

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 <213> *Propionibacterium freudenreichii*

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Arg Ala Ser Gly Arg Ser Val Ala Gly Phe Lys Val Gly Pro Asp Tyr  
 35 40 45

Ile Asp Pro Gly Tyr His Ala Leu Ala Cys Gly Arg Pro Gly Arg Asn  
 50 55 60

Leu Asp Pro Tyr Leu Cys Gly Pro Glu Arg Ile Ala Pro Leu Phe Ala  
 65 70 75 80

His Gly Ala Leu His Pro Glu Pro Ala Asp Ile Ser Val Val Glu Gly  
 85 90 95

Val Met Gly Met Phe Asp Gly Lys Leu Gly Ala Trp Pro Asp Gly Thr  
 100 105 110

Asp Asp Pro Ala Gly Phe Gly Ser Ser Ala His Ile Ala Arg Leu Leu  
 115 120 125

Asp Ala Pro Val Leu Leu Val Val Asp Gly Ser His Ser Ala Arg Thr  
 130 135 140

Ala Ala Ala Leu Cys His Gly Leu Ala Ser Tyr Asp Pro Arg Ile His  
 145 150 155 160

Val Ala Gly Val Ile Leu Asn Arg Val Met Gly Ala Arg Val Val Asp  
 165 170 175

Glu Ile Thr Arg Gly Cys Ala Arg Val Gly Leu Pro Val Leu Gly Ala  
 180 185 190

Leu Pro Lys Ser Thr Arg Val Ala Val Gly Ser Arg His Leu Gly Leu  
 195 200 205

Val Thr Ala Asp Glu Gln Gly Asp Ala Ile Gly Ile Val Gln Gln Ala  
 210 215 220

Gly Glu Leu Val Ala Ala His Leu Asp Leu Asp Ala Ile Ala Thr Ile

225		230		235		240
Ala Gly Gly Ala Pro Asp Leu Ala Val Asp Pro Trp Asp Pro Ala Ala						
		245		250		255
Glu Val Glu Pro Val Pro Gly Arg Pro Val Ile Ala Met Ala Ser Gly						
		260		265		270
Pro Ala Phe Thr Phe Arg Tyr Thr Glu Thr Ala Glu Leu Leu Glu Ala						
		275		280		285
Ala Gly Cys Arg Val Thr Ala Phe Asp Pro Leu Thr Ala Arg Gly Leu						
		290		295		300
Pro Ala Asp Val Ser Gly Leu Tyr Leu Gly Gly Gly Phe Pro Glu Glu						
		310		315		320
His Ala Glu Ala Leu Ala Gly Asn Thr Ser Leu Gly Ala Glu Ile Ala						
		325		330		335
Ser Arg Val Ser Glu Gly Leu Pro Thr Val Ala Glu Cys Ala Gly Leu						
		340		345		350
Leu Tyr Leu Cys Arg Ser Leu Asp Gly Leu Ala Met Ala Gly Val Val						
		355		360		365
Asp Ala Asp Ser Ser Met Thr Pro Arg Leu Thr Ile Gly Tyr His His						
		370		375		380
Ala Arg Ala Ala Asn Asp Ser Phe Leu Met Arg Ala Gly Glu Arg Tyr						
		385		390		400
Arg Ala His Glu Phe His Arg Thr Thr Leu Asp Thr Pro Pro Tyr Asp						
		405		410		415
Arg Asp Pro Gly Pro Gln Arg Leu Gly Asp Gln Arg Leu Ala Trp Asp						
		420		425		430
Val Glu Thr Pro Thr Gly Gly Asn Arg Pro Glu Gly Val Leu Val Ala						
		435		440		445
Pro Thr Pro Gly Ser Ala Pro Ser Val His Ala Ser Tyr Gln His Leu						
		450		455		460
His Trp Ala Gly Ser Pro Val Leu Ala Gln Arg Phe Ala Arg Ala Ala						
		465		470		475
Ser Glu Tyr Gly His Thr Gly His His Ser Pro Arg Pro Ala Ala Thr						
		485		490		495
Thr Pro Gly Asp Ala Leu Ser Ala Ala Pro Asp Leu Thr His His Gly						
		500		505		510
Asp Arg Asp Val Leu Pro Gly Leu Val Asp Leu Ala Val Asn Val Arg						
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Asp Val Arg Pro Pro Ala Trp Leu Val Glu Arg Ile Val Ala Ser Ser						
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Asp Gln Trp Ala His Tyr Pro Asp Gln Arg Glu Ala Thr Arg Ala Val  
 545 550 555 560  
 Ala Leu Arg His Gly Val Asn Pro Asp Gln Val Leu Leu Thr Ala Gly  
 565 570 575  
 Ser Ser Glu Ala Phe Ser Leu Ile Ala His Gly Phe Ser Pro Arg Trp  
 580 585 590  
 Ala Val Val Val His Pro Gln Phe Thr Glu Pro Glu Val Ala Leu Arg  
 595 600 605  
 Asn Ala Gly Arg Pro Val Gly Arg Leu Val Leu His Ala Ser Asp Gly  
 610 615 620  
 Phe Gln Phe Asp His Glu Leu Leu Asp Pro Arg Ala Asp Met Val Val  
 625 630 635 640  
 Ile Gly Asn Pro Thr Asn Pro Thr Gly Val Leu His Ser Ala Ala Ser  
 645 650 655  
 Leu Arg Ala Leu Cys Arg Pro Gly Arg Val Val Val Val Asp Glu Ala  
 660 665 670  
 Phe Met Asp Ala Val Pro Gly Glu Pro Glu Ser Leu Ile Gly Ala Arg  
 675 680 685  
 Met Asp Gly Leu Leu Val Thr Arg Ser Phe Thr Lys Thr Trp Ser Val  
 690 695 700  
 Pro Gly Leu Arg Ile Gly Tyr Val Val Gly Asp Pro Ala Leu Ile Arg  
 705 710 715 720  
 Val Leu Ala His Glu Gln Pro Cys Trp Pro Ile Ser Thr Pro Ala Leu  
 725 730 735  
 Val Thr Ala Arg Glu Cys Ser Thr Pro Arg Ala Val Glu Gln Ala Thr  
 740 745 750  
 Ser Asp Ala Arg Gln Ala Ala Gln Asp Arg Arg His Leu Val Ala Arg  
 755 760 765  
 Leu Ala Gly Ile Gly Ile Gln Thr Val Gly Glu Ala Arg Ala Pro Phe  
 770 775 780  
 Val Leu Val Asp Leu Arg Ala His Pro Pro Gly Gly Leu Arg Ala Gly  
 785 790 795 800  
 Leu Arg Thr Leu Gly Phe Thr Val Arg Ser Gly Glu Ser Phe Pro Gly  
 805 810 815  
 Leu Gly Ala Gly Trp Leu Arg Leu Ala Val Arg His Pro Asp Ile Ser  
 820 825 830  
 Asp Ala Phe Val Ala Ala Leu Ala Arg Thr Ile Asp Ala Leu Asp Thr  
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 <213> *Propionibacterium freudenreichii*

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 Ser Gly Leu Gly Ala Arg Gln Arg Pro Ala Arg Thr Leu Val Thr Gly  
 20 25 30  
 ggc gcc cgg agc ggg aag tcc agc tat gcc gag gcg ctg ctg ggg tcg 144  
 Gly Ala Arg Ser Gly Lys Ser Ser Tyr Ala Glu Ala Leu Leu Gly Ser  
 35 40 45  
 ttc gac cac gtc gac tac atc gcc acc tcg caa cgc aac cct gac gac 192  
 Phe Asp His Val Asp Tyr Ile Ala Thr Ser Gln Arg Asn Pro Asp Asp  
 50 55 60  
 ccc gag tgg atg gcc cgc atc gcc gcc cac gtc gcg cgc cgc ccg aag 240  
 Pro Glu Trp Met Ala Arg Ile Ala Ala His Val Ala Arg Arg Pro Lys  
 65 70 75 80  
 agc tgg aac acc gtg gag acc ctt gac gtg gcg cag gtg ctg tcc gac 288  
 Ser Trp Asn Thr Val Glu Thr Leu Asp Val Ala Gln Val Leu Ser Asp  
 85 90 95  
 gac ggc tcc ccc gcc ctg gtc gat tgc ctg ggc gtg tgg ctc acc cgc 336  
 Asp Gly Ser Pro Ala Leu Val Asp Cys Leu Gly Val Trp Leu Thr Arg  
 100 105 110  
 gag ctg gac gtc acc gac gcc tgg cag cac ccg gag cag gcc cgc ccc 384  
 Glu Leu Asp Val Thr Asp Ala Trp Gln His Pro Glu Gln Ala Arg Pro  
 115 120 125  
 gag ctg cag cac cgc atc gat gag ttg gcc act gcg gtc gcc ggc tcc 432  
 Glu Leu Gln His Arg Ile Asp Glu Leu Ala Thr Ala Val Ala Gly Ser  
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 ccg cgc cgc gtg gtg ctg gtc acc aac gag gtc ggt tcc ggc gtg gtg 480  
 Pro Arg Arg Val Val Leu Val Thr Asn Glu Val Gly Ser Gly Val Val  
 145 150 155 160  
 ccc gcc acg cag gca ggg cgc acc ttc cgt gac tgg ctg gga atc ctc 528  
 Pro Ala Thr Gln Ala Gly Arg Thr Phe Arg Asp Trp Leu Gly Ile Leu  
 165 170 175  
 aac gcc agc gtc gcg gac gcc tgc gac gag gta ctg ctg tgc gtc gcc 576  
 Asn Ala Ser Val Ala Asp Ala Cys Asp Glu Val Leu Leu Cys Val Ala



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                180                185                190
gga cgg gcg ctg agc ctg cca ccg cga ccg gga ggc cct cat ggc gcc      624
Gly Arg Ala Leu Ser Leu Pro Pro Arg Pro Gly Gly Pro His Gly Ala
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ggc acg gac ccc caa ccg aag gac gcg atc tga      657
Gly Thr Asp Pro Gln Pro Lys Asp Ala Ile
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<212> PRT
<213> Propionibacterium freudenreichii

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Ser Gly Leu Gly Ala Arg Gln Arg Pro Ala Arg Thr Leu Val Thr Gly
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Gly Ala Arg Ser Gly Lys Ser Ser Tyr Ala Glu Ala Leu Leu Gly Ser
                35                40                45

Phe Asp His Val Asp Tyr Ile Ala Thr Ser Gln Arg Asn Pro Asp Asp
50                55                60

Pro Glu Trp Met Ala Arg Ile Ala Ala His Val Ala Arg Arg Pro Lys
65                70                75                80

Ser Trp Asn Thr Val Glu Thr Leu Asp Val Ala Gln Val Leu Ser Asp
                85                90                95

Asp Gly Ser Pro Ala Leu Val Asp Cys Leu Gly Val Trp Leu Thr Arg
                100                105                110

Glu Leu Asp Val Thr Asp Ala Trp Gln His Pro Glu Gln Ala Arg Pro
                115                120                125

Glu Leu Gln His Arg Ile Asp Glu Leu Ala Thr Ala Val Ala Gly Ser
130                135                140

Pro Arg Arg Val Val Leu Val Thr Asn Glu Val Gly Ser Gly Val Val
145                150                155                160

Pro Ala Thr Gln Ala Gly Arg Thr Phe Arg Asp Trp Leu Gly Ile Leu
                165                170                175

Asn Ala Ser Val Ala Asp Ala Cys Asp Glu Val Leu Leu Cys Val Ala
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Gly Thr Asp Pro Gln Pro Lys Asp Ala Ile
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 <213> *Propionibacterium freudenreichii*

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 ctg ccc gca ccc gtg gtg gcc gag gtg gat gag cga ctc gcc gtg cgg 96  
 Leu Pro Ala Pro Val Val Ala Glu Val Asp Glu Arg Leu Ala Val Arg  
 20 25 30  
 gcg atc gcc tcg atg ccg tgg gtc ggc ctc gga ctg ggc ctg atc gcc 144  
 Ala Ile Ala Ser Met Pro Trp Val Gly Leu Gly Leu Gly Leu Ile Ala  
 35 40 45  
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 Gly Leu Gly Cys Ala Ile Val Thr Val Ala Gly Gly Gly Gln Pro Leu  
 50 55 60  
 gca atc gca gca ggc ctg gca atc ctg gcc ctg tgc acc ggc ttc ctg 240  
 Ala Ile Ala Ala Gly Leu Ala Ile Leu Ala Leu Cys Thr Gly Phe Leu  
 65 70 75 80  
 cac ctc gac gga ctc gcc gac acc gcc gac ggc ctg ggc tcc cgc aag 288  
 His Leu Asp Gly Leu Ala Asp Thr Ala Asp Gly Leu Gly Ser Arg Lys  
 85 90 95  
 ccg gcc cac gag gcc ctg acc atc atg cgc caa tca gac atc ggg ccc 336  
 Pro Ala His Glu Ala Leu Thr Ile Met Arg Gln Ser Asp Ile Gly Pro  
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 atg ggc gtc acc gcc atc atc ctc gtg ctg gcg ttg gag atc gcg gca 384  
 Met Gly Val Thr Ala Ile Ile Leu Val Leu Ala Leu Glu Ile Ala Ala  
 115 120 125  
 ggc ggt tca gga cac ctt gat ggc tgg cgt ggc gtc tgg ctg ctg gtg 432  
 Gly Gly Ser Gly His Leu Asp Gly Trp Arg Gly Val Trp Leu Leu Val  
 130 135 140  
 aca atg ccc atg gtg gcg cgc gtc agc gcc ctg tcc gcc acc gga cga 480  
 Thr Met Pro Met Val Ala Arg Val Ser Ala Leu Ser Ala Thr Gly Arg  
 145 150 155 160  
 tgg att ccg agc gcc cac aag aag ggg ttc gga gcg ctc ttc gcc gga 528  
 Trp Ile Pro Ser Ala His Lys Lys Gly Phe Gly Ala Leu Phe Ala Gly  
 165 170 175  
 aag acg cac cct gcg acg atc gtg gtc gcc tca gtg atc gcc gcg gtg 576  
 Lys Thr His Pro Ala Thr Ile Val Val Ala Ser Val Ile Ala Ala Val  
 180 185 190

atc gcc gcg ggc agt gga tgg ctg ctc ttc ggc tgg cgg gcc gcc ctc 624  
 ile ala ala gly ser gly trp leu leu phe gly trp arg ala ala leu  
           195                          200                          205  
  
 gtg gcg gtg tgt gcc tgc ctg gcc agc tgg gtc ttc ggc gtg gcg tgg 672  
 val ala val cys ala cys leu ala ser trp val phe gly val ala trp  
           210                          215                          220  
  
 cgc cgc cat atc ctg gcg cgg ctc gga gga ctg acc ggc gac acc ttc 720  
 arg arg his ile leu ala arg leu gly gly leu thr gly asp thr phe  
           225                          230                          235                          240  
  
 ggg tcc ctg gtc gag atg agc gcc ctg gcc tat ttg ttg acc ctg gca 768  
 gly ser leu val glu met ser gly leu ala tyr leu leu thr leu ala  
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 ttg ttc gcc tga 780  
 leu phe ala

<210> 6  
 <211> 259  
 <212> PRT  
 <213> *Propionibacterium freudenreichii*

<400> 6  
 Met ala thr arg asn gly leu leu ala ala trp gly leu phe thr val  
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 leu pro ala pro val val ala glu val asp glu arg leu ala val arg  
           20                          25                          30  
  
 ala ile ala ser met pro trp val gly leu gly leu gly leu ile ala  
           35                          40                          45  
  
 gly leu gly cys ala ile val thr val ala gly gly gly gln pro leu  
           50                          55                          60  
  
 ala ile ala ala gly leu ala ile leu ala leu cys thr gly phe leu  
           65                          70                          75                          80  
  
 his leu asp gly leu ala asp thr ala asp gly leu gly ser arg lys  
                           85                          90                          95  
  
 pro ala his glu ala leu thr ile met arg gln ser asp ile gly pro  
                           100                          105                          110  
  
 met gly val thr ala ile ile leu val leu ala leu glu ile ala ala  
           115                          120                          125  
  
 gly gly ser gly his leu asp gly trp arg gly val trp leu leu val  
           130                          135                          140  
  
 thr met pro met val ala arg val ser ala leu ser ala thr gly arg  
           145                          150                          155                          160  
  
 trp ile pro ser ala his lys lys gly phe gly ala leu phe ala gly

165										170					175															
Lys	Thr	His	Pro	Ala	Thr	Ile	Val	Val	Ala	Ser	Val	Ile	Ala	Ala	Val															
			180						185				190																	
Ile	Ala	Ala	Gly	Ser	Gly	Trp	Leu	Leu	Phe	Gly	Trp	Arg	Ala	Ala	Leu															
			195				200					205																		
Val	Ala	Val	Cys	Ala	Cys	Leu	Ala	Ser	Trp	Val	Phe	Gly	Val	Ala	Trp															
			210				215				220																			
Arg	Arg	His	Ile	Leu	Ala	Arg	Leu	Gly	Gly	Leu	Thr	Gly	Asp	Thr	Phe															
					230					235					240															
Gly	Ser	Leu	Val	Glu	Met	Ser	Gly	Leu	Ala	Tyr	Leu	Leu	Thr	Leu	Ala															
				245					250						255															

Leu Phe Ala

<210> 7  
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 <212> DNA  
 <213> *Propionibacterium freudenreichii*

<220>  
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atg	agc	gga	tcc	gcg	ccg	cag	cgc	acc	gag	ccg	acc	acc	gcc	gaa	ctg	48				
Met	Ser	Gly	Ser	Ala	Pro	Gln	Arg	Thr	Glu	Pro	Thr	Thr	Ala	Glu	Leu					
1				5					10					15						
cgc	cac	cgc	ccc	cga	ctg	atc	gtg	aac	acc	ggg	aac	ggc	aag	ggc	aag	96				
Arg	His	Arg	Pro	Arg	Leu	Ile	Val	Asn	Thr	Gly	Asn	Gly	Lys	Gly	Lys					
			20					25					30							
tcc	acc	gcc	gca	ttc	ggc	atg	gga	ctg	cgg	gcc	tgg	gcg	cag	ggc	tgg	144				
Ser	Thr	Ala	Ala	Phe	Gly	Met	Gly	Leu	Arg	Ala	Trp	Ala	Gln	Gly	Trp					
			35				40						45							
tcg	atc	ggg	gtc	ttc	cag	ttc	atc	aag	tcg	gga	cgt	tgg	cac	acc	ggc	192				
Ser	Ile	Gly	Val	Phe	Gln	Phe	Ile	Lys	Ser	Gly	Arg	Trp	His	Thr	Gly					
			50				55				60									
gag	cag	cag	gcc	tat	gca	cag	ctc	gac	cag	gcc	cat	cgg	acg	acc	gga	240				
Glu	Gln	Gln	Ala	Tyr	Ala	Gln	Leu	Asp	Gln	Ala	His	Arg	Thr	Thr	Gly					
			65		70					75					80					
gtc	ggc	gga	ccg	gtg	gaa	tgg	caa	tca	ctc	gga	tcc	ggc	tgg	tcg	tgg	288				
Val	Gly	Gly	Pro	Val	Glu	Trp	Gln	Ser	Leu	Gly	Ser	Gly	Trp	Ser	Trp					
				85					90					95						
ctg	agg	gcg	acc	gag	ggc	acc	gac	cag	gca	gcc	atg	gcg	gcc	gcg	ggc	336				
Leu	Arg	Ala	Thr	Glu	Gly	Thr	Asp	Gln	Ala	Ala	Met	Ala	Ala	Ala	Gly					
				100					105					110						

tgg gcc cac gtg cgc acc ctg ctc gcc gca cag acc cac cgg ctc tac 384  
 Trp Ala His Val Arg Thr Leu Leu Ala Ala Gln Thr His Arg Leu Tyr  
 115 120 125  
 atc ctc gac gaa ttc gcc cat gtg ctc aac aag gga tgg ctg gat gtc 432  
 Ile Leu Asp Glu Phe Ala His Val Leu Asn Lys Gly Trp Leu Asp Val  
 130 135 140  
 gac gag gtc gct gac gac ctg gca cat cgt ccc ggc acg caa cat gtg 480  
 Asp Glu Val Ala Asp Asp Leu Ala His Arg Pro Gly Thr Gln His Val  
 145 150 155 160  
 gtg atc acc gga cgc aac tgc ccc gcc gga atc atc ggg atc gcc gac 528  
 Val Ile Thr Gly Arg Asn Cys Pro Ala Gly Ile Ile Gly Ile Ala Asp  
 165 170 175  
 atc gtc acg tcc atg gac aac gtc aaa cat ccc ttt ggc aag gga gaa 576  
 Ile Val Thr Ser Met Asp Asn Val Lys His Pro Phe Gly Lys Gly Glu  
 180 185 190  
 cga gga cag gcg ggt atc gaa tgg tga 603  
 Arg Gly Gln Ala Gly Ile Glu Trp  
 195 200

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 <212> PRT  
 <213> *Propionibacterium freudenreichii*

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 Ser Thr Ala Ala Phe Gly Met Gly Leu Arg Ala Trp Ala Gln Gly Trp  
 35 40 45  
 Ser Ile Gly Val Phe Gln Phe Ile Lys Ser Gly Arg Trp His Thr Gly  
 50 55 60  
 Glu Gln Gln Ala Tyr Ala Gln Leu Asp Gln Ala His Arg Thr Thr Gly  
 65 70 75 80  
 Val Gly Gly Pro Val Glu Trp Gln Ser Leu Gly Ser Gly Trp Ser Trp  
 85 90 95  
 Leu Arg Ala Thr Glu Gly Thr Asp Gln Ala Ala Met Ala Ala Ala Gly  
 100 105 110  
 Trp Ala His Val Arg Thr Leu Leu Ala Ala Gln Thr His Arg Leu Tyr  
 115 120 125  
 Ile Leu Asp Glu Phe Ala His Val Leu Asn Lys Gly Trp Leu Asp Val  
 130 135 140  
 Asp Glu Val Ala Asp Asp Leu Ala His Arg Pro Gly Thr Gln His Val

145                      150                      155                      160  
 Val Ile Thr Gly Arg Asn Cys Pro Ala Gly Ile Ile Gly Ile Ala Asp  
                                  165                      170                      175  
 Ile Val Thr Ser Met Asp Asn Val Lys His Pro Phe Gly Lys Gly Glu  
                                  180                      185                      190  
 Arg Gly Gln Ala Gly Ile Glu Trp  
                                  195                      200

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<220>  
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<400> 9

GGGATCCTCT AGAGCATGCA AGCTTCTCGA GAATCGATAG ATCTCTAAGG AAGCTAAAAT 60  
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<211> 31  
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<400> 10

CAGTAGATCT CGACAAGGAG GAACCCATGA G 31

<211> 30  
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<400> 11

CGTAAGATCT CAGTTTCGGA CATGGCAGTG 30

<211> 24  
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<220>  
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<400> 12

CACCACCAAC ATCGATGAGG AAAC 24

<211> 25  
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<220>  
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<400> 13

TCCAATTGGG ACTCAGTGGT CGCTG

25

<211> 39  
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39

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<220>  
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<400> 15

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28

<211> 39  
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CTGATATCAA TTGGAGGACA TCAGATGACC CGCATCGTC

39

<211> 29  
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<400> 17

CTGAATTCCG GCGGCTCAGG CGAACAATG

29